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CONSTRUCTION METRICATION

Acknowledgements
"METRIC NEWSLETTER"
and slides by the
Construction Metrication Council

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FACTS ABOUT CONSTRUCTION METRICATION

- **English is the international language of business**
- **Metric is the international language of measurement**

FACT:

Metrication is largely a paper change and the paper change is largely complete

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FACT:

The model codes and most construction standards contain metric units, as do all federal and state highway standards, criteria, and specifications

FACT:

Contractors adapt rapidly

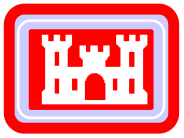
Work is still done

the same way

by the same people

with the same skills...

and with the same experience,
using almost the same products,
and almost all of
the same tools and equipment



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Important Definitions to Understand

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"Hard" Metric

- Hard metric means designing and constructing elements to rational metric dimensions which are convenient to work with, visualize and remember.
- Using components or dimensions that were originally selected in modular metric units of measure. Units tend to have professionally rounded off values.

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"Hard" Metric Examples

- Visualize and remember items such as the use of 100 mm in lieu of 4 inches.
- Distance above the floor. (400mm for wall outlet)
- Products are considered to be hard metric when they are manufactured to metric dimensions or have an industry recognized metric designation.

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"Soft" Metric

- Mathematically converted inch/pound values to exact or nearly exact metric values using conversion formulas. (e.g. 38.1 mm (1-1/2 inches))
- Soft metric measurements are used for measurements pertaining to products, test values, and other situations where the I-P units are the standard for manufacture, verification, or other controlling factor.

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"Soft" Metric Materials

- A soft metric measurement is also indicated for products that are manufactured in industry designated metric dimensions but are required by law to allow substitute I-P products. These measurements are indicated by a manufacturing hard metric product dimension followed by the substitute I-P equivalent value in parentheses (e.g., 190 x 190 x 390 mm (7-5/8 x 7-5/8 x 15-5/8 inches))

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Neutral Materials

- A neutral measurement is indicated by an identifier which has no expressed relation to either an SI or an I-P value (e.g., American Wire Gage (AWG) which indicates thickness but in itself is neither SI nor I-P).

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Exceptions to Hard Metric Product Policy

- Concrete Masonry Unit Block (CMU)
- Recessed Light Fixtures (RLF)
- Ceiling Tile (Diffusers/Grills/Registers)
- Public Law 104-289 of October 11, 1996, Savings in Construction Act of 1996 (110 Stat. 3411) states that "a Federal agency may require that specifications for the acquisition of structures or systems of concrete masonry be expressed under the metric system of measurement, but may not incorporate specifications, that can only be satisfied by hard-metric versions of concrete masonry units, .. unless.. 1) hard-metric specifications are necessary in a contract for the repair or replacement of parts .. in existence or under construction upon the effective date of the Savings in Construction Act of 1996; or 2) the following 2 criteria are met: (A) the application requires hard-metric concrete masonry units to coordinate dimensionally into 100 millimeter building modules; and (B) the total installed price of hard-metric concrete masonry units is estimated to be equal to or less than the total installed price of using non-hard-metric concrete masonry units." The Savings in Construction Act of 1996 also contains similar requirements for recessed lighting fixtures.

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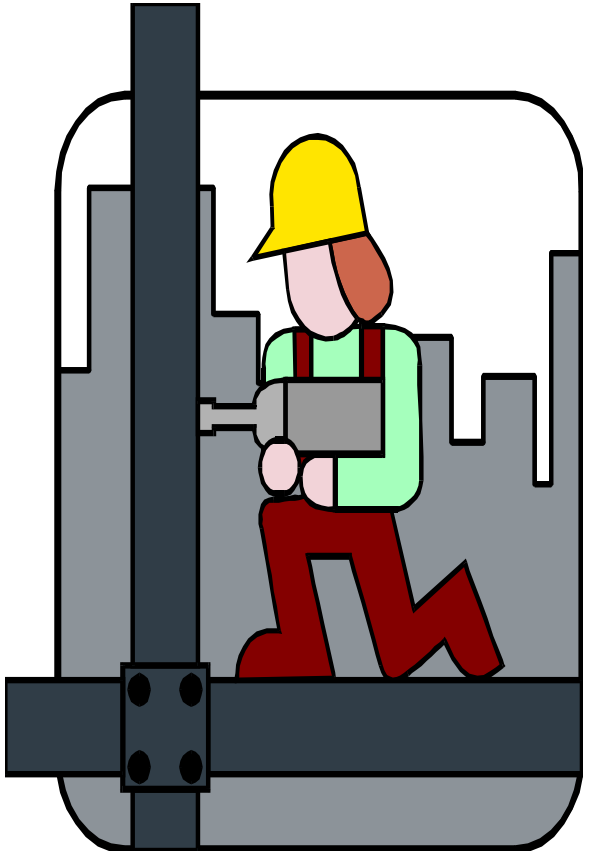
Metrics in Construction

Public law (P.L 104-289) recognizes the use of 100 mm building design module as the preferred design module. The law also takes into account the total installed price, as opposed to a simple material cost when choosing between a hard and soft metric version of CMU and RLF in a metric project. This is because Lawmakers recognized the fact that use of modular or hard metric materials saves labor costs by avoiding unnecessary cutting or trimming.



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Building Design

- Sitework in metric, .25M interval contour lines.
- Building dimensions in hard metric.
- Building module 100 mm
- Specs in metric
- I-P material substitution for CMU & RLF possible - YES
- Site - adapts of I-P designs are to be new hard metric designs based on I-P building (not soft metric!)

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Metric-related problems have been FEW

Schedules have been UNAFFECTED

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FACT:

Little metric training
is needed for most crafts

Almost all training
can be performed
on-the-job

THE BENEFITS

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BENEFIT:

Metrication will increase construction's

EFFICIENCY AND QUALITY

The simplicity of a decimal-based system speeds work and reduces errors

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WHAT WILL CHANGE AND WHAT WILL STAY THE SAME

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METRIC MODULE AND GRID

- ***What will change***
  - The basic building module,
    from 4 inches to **100 mm**.
- ***What will stay the same***
  - The use of modules, easy-to-use dimensions.

The **100 module** is the global standard.

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DRAWINGS

- ***What will change***
  - Units of measure, from feet and inches to **millimeters** for all building dimensions and to **meters** for large site plans and civil engineering drawings.

    Unit notations are unnecessary:

    if there's no decimal point, it's millimeters;

    if there's a decimal point carried to one, two or three places, it's meters.

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Drawings Cont.

In accordance with ASTM E621, **centimeters are not used in construction** because

(1) they are not consistent with the preferred use of multiples that represent tertiary powers of ten,

(2) the order of magnitude between a millimeter and centimeter is only 10 and the use of both units would lead to confusion, and requires the use of unit symbols on drawings

(3) The use of millimeters almost entirely eliminates decimal fractions.

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NEVER use both inch-pound and metric units on a drawing!

Using dual units:

--Increases dimensioning time

--Doubles the chance for errors

--Makes drawing more confusing

--Postpones the learning process

DRAWING SCALES

- Drawing scales change from inch-fractions-to-feet to true ratios.
  - Preferred metric scales are:
    - **1:1** (full size)
    - **1:5** (close to 3" = 1'-0")
    - **1:10** (between 1" = 1'-0" and 1-1/2" = 1'-0")
    - **1:20** (between 1/2" = 1'-0" and 3/4" = 1'-0")
    - **1:50** (close to 1/4" = 1'-0")
    - **1:100** (close to 1/8" = 1'-0")
    - **1:200** (close to 1/16" = 1'-0")
    - **1:500** (close to 1" = 40'-0")
    - **1:1000** (close to 1" = 80'-0")

As a means of comparison, inch-fraction scales may be converted to true ratios by multiplying the scale's divisor by 12 (for example, for 1/4" = 1'-0", multiply the 4 by 12 for a true ratio of 1:48).

Inch-fraction scales can be converted to true ratio scales by multiplying the scale's divisor by 12 (inches)

For example, for 1/4" = 1'-0", multiply the divisor, 4, by 12 for a true ratio of 1:48; this is very close to the metric scale of 1:50

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DRAWING SIZES

- ***What will Change***
  - Drawing sizes, to ISO "A" series:
    - **A0** (**1189 × 841 mm**, 46.8 × 33.1 inches)
    - ***A1 (841 × 594 mm, 33.1 × 23.4 inches)***
    - **A2** (**594 × 420 mm**, 23.4 × 16.5 inches)
    - **A3** (**420 × 297 mm**, 16.5 × 11.7 inches)
    - **A4** (**297 × 210 mm**, 11.7 × 8.3 inches)
    - Of course, metric drawings can be made on any size paper.
- ***What will stay the same***
  - Drawing contents.

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SPECIFICATIONS

- ***What will change***
  - Units of measure, from inch-pound to metric units.
- ***What will stay the same***
  - Everything else in the specifications.
  - Do not use dual units in specifications except when the use of an inch-pound measure serves to clarify an otherwise unfamiliar metric measure; then place the inch-pound unit in parentheses after the metric— for example, "7.5 KW (10 horse-power) motor." All unit conversions should be **checked by a professional** to ensure that rounding does not exceed allowable tolerances.

CONSTRUCTION PRODUCTS IN GENERAL

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What will change:

A few modular products,
such as concrete block,
drywall, plywood, suspended
ceilings, and raised floors...

plus

products that are fabricated or formed for each job, such as

cabinets, wood trusses, ductwork, commercial doors and windows, and concrete work

Such products usually can be made in inch-pound or metric sizes with equal ease

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What will stay the same:

All other products,
since they are cut-to-fit,
like:

framing materials, structural steel, wood trim, siding, wiring, piping, and roofing...

…or their placement is not dimensionally sensitive, like:

fasteners, hardware, electrical components, plumbing fixtures, and HVAC equipment

Such products simply will be relabeled in metric units

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STUDS

- ***"2 X 4" STUDS AND OTHER "2-BY" WOOD AND METAL FRAMING MEMBERS***
- ***What will change***
  - Spacing, from 16" to **400 mm** and 24" to **600 mm**.
- ***What will stay the same***
  - Framing member cross sections.
  - Since"2-bys" are produced in "soft" fractional inch dimensions, there is no need to convert them to new, rounded "hard" metric dimensions. “2 x 4s” may keep their traditional name or perhaps they'll eventually be called “50 x 100s” (mm) or, more exactly but less likely, “38 x 89s.”

Metric-spaced framing members are placed slightly closer together than normal, since

400 mm = 15.7”

600 mm = 23.6”

What will stay the same:

Everything else;
2x4s will not change size

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DRYWALL, PLYWOOD, OSB, PARTICLE BOARD, AND RELATED SHEET PRODUCTS

- ***What will change***
  - Widths, from 4'-0" to **1200 mm**.
  - Heights, from 8'-0" to **2400 mm** and from 10'-0" to **3000 mm**.
- ***What will stay the same***
  - Thicknesses, so fire, acoustic, and thermal ratings won't have to be recalculated.
  - Metric drywall and plywood are readily available but may require longer delivery lead times and may cost more in small amounts until their use becomes more common.

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BATT INSULATION

- What will change
  - Nothing, although batts may be relabeled to include nominal metric widths, such as **16"/400 mm** or **24"/600 mm**.
- R-Values will be expressed in metric. The conversion is R_{uscs} X 0.1761102 = R_{metric} (See chart next page)
- What will stay the same
  - Everything else.
  - Batts will not change in width; they'll just have a tighter "friction fit" when installed between metric-spaced framing members.

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R-values

- R-Values will be expressed in metric. The conversion is $R_{uscs} \times 0.1761102 = R_{metric}$

U.S.C.S.	Metric
3	0.53
3.85	0.68
6	1.06
8	1.41
11	1.94
13	2.29
15	2.64
18	3.17
19	3.35
21	3.7
22	3.87
25	4.4
26	4.58
30	5.28
38	6.69

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DOORS

- ***What will change***
  - Heights, from 6'-8" to **2050 mm** or **2100 mm** and from 7'-0" to **2100 mm**.
  - Widths, from
    30" to **750 mm**;
    32" to **800 mm**;
    34" to **850 mm**;
    36" to **900 mm** or **950 mm**; and
    40" to **1000 mm**.
- ***What will stay the same***
  - Door thicknesses, door materials and hardware so fire, acoustic, and thermal ratings won't have to be recalculated

That said,
conventional inch-pound doors can be used in many metric wall applications
(such as drywall partitions)
with equal ease

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SUSPENDED CEILING SYSTEMS

- ***What will change***
  - Grid spacing and lay-in ceiling tile, air diffusers, and recessed lighting fixtures (troffers):

    from 2' × 2' to **600 × 600 mm** and (23.6” × 23.6”)

    from 2' × 4' to **600 × 1200 mm** (23.6” × 47.2”).
- ***What will stay the same***
  - Grid profiles, tile thicknesses, air diffuser capacities, fluorescent tubes, and means of suspension.

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SUSPENDED CEILING SYSTEMS

Note: **The Cox Bill (P.L. 104-289) prohibits federal contract documents from solely specifying modular metric recessed lighting fixtures** .

The layout and specification of metric fixtures and ceiling systems may continue but specifications must allow contractors to substitute inch-pound components.

The use of metric recessed fixtures may present installation problems since they cannot be placed end-to-end or end-to-wall

Double Check and Coordinate

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RAISED FLOOR SYSTEMS

- ***What will change***
  - Grids and lay-in floor tile,

    from 24” × 24” to **600 × 600 mm**.
- ***What will stay the same***
  - Grid profiles, tile thicknesses, and means of support.

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BRICK

- ***What will change***
  - Standard brick, to **90 × 57 × 190 mm** .
  - Mortar joints, from 3/8" to **10 mm**.
  - Brick module, from various sizes to **600 × 600 mm**.
- ***What will stay the same***
  - Standard brick sizes and everyday masonry practices.
  - Of the 100 or so brick sizes currently made, most are within a millimeter of a metric brick size, so the brick industry has no trouble supplying “metric” brick.

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CONCRETE BLOCK

- ***What will change***
  - Block sizes from 7-5/8”×15-5/8” face to **190 × 390 mm** (7-1/2 ×15-3/8”)
  - Mortar joints, from 3/8" to **10 mm**.
  - Block module, from 8” × 16” to **200 × 400 mm**.

  Notice that conventional block is 1/8” taller and 1/4” longer than metric block.

  The layout and specification of block walls will be metric but specifications must allow contractors to substitute inch-pound block **. Inch-pound block must be cut to fit the metric building dimensions and opening sizes if used.**

  Note: **The Cox Bill (P.L. 104-289) prohibits federal contract documents from solely specifying modular metric concrete block.**

- ***What will stay the same***
  - Everyday masonry practices.

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HVAC CONTROLS

- ***What will change***
  - Temperature units, from Fahrenheit to Celsius.
- ***What will stay the same***
  - Everything else.
  - Controls are now digital so temperature conversions can be made with no difficulty.

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SHEET METAL

- ***What will change***
  - Designations, from "gage" to millimeters.
- ***What will stay the same***
  - Metal thicknesses.
  - When specifying sheet metal in metric units, SMACNA recommends stating minimum thicknesses; using soft-converted thicknesses may be confusing to suppliers.

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CONCRETE

- ***What will change***
  - Strength designations, from "psi" to megapascals rounded to the nearest 5 MPa per ACI 318M as follows:
    - 2500 psi to **20 MPa**
    - 3000 psi to **25 MPa**
    - 3500 psi to **25 MPa**
    - 4000 psi to **30 MPa**
    - 4500 psi to **35 MPa**
    - 5000 psi to **35 MPa**
- Depending on exact usage, however, the above metric conversions may be more exact than those indicated.
- ***What will stay the same***
  - Everything else.

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PIPE AND FITTINGS

- ***What will change***
  - Nominal pipe and fitting designations, from inches to millimeters.
- ***What will stay the same***
  - Pipe and fitting cross sections and threads.
  - Pipes and fittings are produced in "soft" decimal inch dimensions but are identified in nominal inch sizes as a matter of convenience. A 2-inch pipe has neither an inside nor an outside diameter of 2 inches, a 1-inch fitting has no exact 1-inch dimension, and a 1/2-inch sprinkler head contains no 1/2-inch dimension anywhere; consequently, there is no need to "hard" convert pipes and fittings to rounded metric dimensions.

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PIPE AND FITTINGS Cont.

- ***What will stay the same***
  - They will not change size but simply be relabeled in metric units as follows:
    - » 1/8" = **6 mm**
    - » 3/16" = **7 mm**
    - » 1/4" = **8 mm**
    - » 3/8" = **10 mm**
    - » 1/2" = **15 mm**
    - » 5/8" = **18 mm**
    - » 3/4" = **20 mm**
    - » 1” = **25 mm**
    - » 1-1/4" = **32 mm**
    - 1-1/2"` = **40 mm**
    - 2" = **50 mm**
    - 2-1/2" = **65 mm**
    - 3" = **75 mm**
    - 3-1/2" = **90 mm**
    - 4" = **100 mm**
    - 4-1/2" = **115 mm**
    - 1" = 25 mm for all larger sizes

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REBAR

- ***What will change***
  - Rebar will be renamed per ASTM A615M-96a and ASTM A706M-96a as follows:
    - No. 3 to **No. 10**
    - No. 4 to **No. 13**
    - No. 5 to **No. 16**
    - No. 6 to **No. 19**
    - No. 7 to **No. 22**
    - No. 8 to **No. 25**
    - No. 9 to **No. 29**
    - No. 10 to **No. 32**
    - No. 11 to **No. 36**
    - No. 14 to **No. 43**
    - No. 18 to **No. 57**
- ***What will stay the same***
  - Rebar cross sections

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GLASS

- ***What will change***
  - Cut sheet dimensions, from feet and inches to millimeters.
- ***What will stay the same***
  - Sheet thickness. Sheet glass can be produced in any thickness and often is made in even millimeter sizes. See ASTM C1036.

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ELECTRICAL CONDUIT

- ***What will change***
- Conduit designations, from inches to millimeters.
- ***What will stay the same***
  - Conduit cross sections.
  - Electrical conduit is similar to piping: it is produced in "soft" decimal inch dimensions but is identified in nominal inch sizes. Neither metallic nor nonmetallic conduit will change size; both will be relabeled in metric units as follows:
    - 1/2" = **16** (mm)
    - 3/4" = **21** (mm)
    - 1" = **27** (mm)
    - 1-1/4" = **35** (mm)
    - 1-1/2" = **41** (mm)
    - 2" = **53** (mm)
    - 2-1/2" = **63** (mm)
    - 3" = **78** (mm)
    - 3-1/2" = **91** (mm)
    - 4" = **103** (mm)
    - 5" = **129** (mm)
    - 6" = **155** (mm)

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ELECTRICAL WIRE

- ***What will change***
  - Nothing at this time.
- ***What will stay the same***
  - Existing American Wire Gage (AWG) sizes.

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STRUCTURAL STEEL

- ***What will change***
  - Section designations, from inches to **millimeters** and from pounds per foot to **kilograms per meter**, in accordance with ASTM A6M.
  - Bolts, to metric diameters and threads per ASTM A325M and A490M.
- ***What will stay the same***
  - Cross sections.
    - Like pipe and conduit, steel sections are produced in "soft" decimal inch dimensions (with actual depths varying by weight). They are designated in both rounded inch dimensions and rounded (to the nearest 10 mm) metric dimensions. Thus, a 10-inch section is also designated as a 250-mm section and a 24-inch section is also designated as a 610-mm section.

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Metric Guides

- ***CONSTRUCTION METRICATION COUNCIL***
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GO METRIC!